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second, and third surfaces being fixedly located relative to one another, thereby to form an assembly, and rotating said assembly about said first axis; said beam thereafter impinging on said nozzle plate, thereby to form a nozzle.

C<sup>2</sup>  
31. (Amended) Apparatus for forming a nozzle in a nozzle plate for an ink jet printhead, said apparatus comprising a nozzle plate substrate and a source of a high energy beam having a first axis extending in a first direction; and an assembly comprising a first reflecting surface lying at an angle to said first reflecting surface lying at an angle to said first direction, a second reflecting surface, and a third reflecting surface, said first, second, and third reflecting surfaces being fixedly located relative to one another such that said high energy beam is reflected by said first reflecting surface towards said second reflecting surface and said third reflecting surface, thereby to both invert said beam and direct said beam along a second axis colinear with said first axis extending in the first direction; said assembly being rotatable about said first axis, and said nozzle plate substrate being partly disposed within a path defined by said second axis to be impinged upon by said beam.

#### REMARKS

Claims 9, 23-25, 31, 34, and 35 were pending in the application. By this paper, claims 23 and 31 have been amended, and all of the above claims remain pending. Reconsideration and withdrawal of the various rejections are hereby respectfully solicited in view of the foregoing amendments and the following remarks.

#### Allowable Subject Matter

The applicants gratefully acknowledge that claim 34 is considered allowable, but for being dependent upon a rejected base claim. However, claim 34 has not been amended herein in view of the following remarks, some of which are directed specifically to the allowability of base claim 9.

#### Claim Rejections - 35 U.S.C. §112

Claims 9, 23-25, 31, 34, and 35 have been rejected under §112, first paragraph, as containing subject matter that is allegedly not enabled in the specification. The independent claims 9, 23, and 31 have been rejected in view of the limitations of a laser beam being "inverted" and directed "along an axis collinear with said first axis" by reflecting a beam off a "planar reflecting surface" and either a "further beam reflecting means" (claim 9) or a

"second reflecting surface" (claims 23 and 31). The official action states that inversion of a laser beam, as disclosed within the specification and drawings and as is known in the art, can only occur when reflected off *three* reflecting surfaces, and that inversion of a beam cannot occur when using only *two* reflecting surfaces.

Claims 23 and 31 have been amended herein to incorporate three reflecting surfaces. The rejection of claims 23 and 31, as amended, is overcome.

Claim 9 has not been amended herein with respect to these limitations. Claim 9 recites that the high energy beam is directed at a *first planar reflecting surface* lying at an angle to the first direction. Claim 9 further recites that this *surface* is "arranged so as to reflect said beam towards *further beam reflecting means* so arranged as to both invert said beam and direct said beam along an axis colinear with said first axis extending in a first direction." The recitation of a further beam *reflecting means* is not limited to only one reflective surface. Instead, the reflecting "means" is interpreted to encompass the structures (i.e. *second and third surfaces*) disclosed within the specification that perform the function of inverting and redirecting the beam as claimed. Thus, claim 9 as currently written is enabled by the specification and describes a structure capable of performing the claimed functions. The rejection of claim 9 is overcome in view of the foregoing remarks.

The rejections under §112 of claims 9, 23, and 31, and dependent claims 24, 25, 34, and 35 should be withdrawn, and such action is respectfully solicited.

#### **Claim Rejections - 35 U.S.C. §102**

Claim 31 has been rejected under §102(e) as anticipated by Shei et al., U.S. Patent No. 5,56,238 (Shei). Shei discloses a laser beam energy delivery system for use in surgical vision correction procedures. The disclosed structure in Shei includes a laser beam 110 that is controllably delivered from a source to a beam homogenizer 130. The homogenizer 130 then transmits the laser beam, reshaped into a circular beam 140 along the same axis of the beam 110 entering the homogenizer 130. The laser beam 140 is then directed to conduct a laser vision correction surgical procedure.

Shei does not disclose directing the beam at a surface of a substrate for preparing or forming ink jet nozzles in the substrate. Claim 31, as amended, recites that the apparatus includes a nozzle plate substrate positioned partly within a path defined by the second axis of the beam after it has been reflected, inverted and redirected by the reflective surface assembly. Shei does not disclose or suggest such an apparatus.

Shei fails to disclose all of the limitations of claim 31 as amended. Claim 31 is neither anticipated nor rendered obvious by the teachings of Shei for at least this reason.

### **Claim Rejections - 35 U.S.C. §103**

Claims 9, 23, 24, and 31 have been rejected under §103(a) as obvious over Nishiwaki et al., U.S. Patent No. 5,263,250 (Nishiwaki) in view of Shei. Claim 25 has been rejected as obvious over Nishiwaki in view of Shei, and further in view of Daly, U.S. Patent No. 4,316,074 (Daly). Claim 35 has been rejected as obvious over Nishiwaki in view of Shei, and in further in view of Hizny, U.S. Patent No. 5,048,938 (Hizny). The primary rejection of independent claims 9, 23, and 31 is based on the combination of Nishiwaki in view of Shei. For the following reasons, these claims are not rendered obvious by the purported combination.

### **References Fail to Disclose All Limitations of Claim 9**

Claim 9 recites, in part, passing the beam through a beam converging means before "*impingement on the face of said nozzle plate in which said nozzle outlet is formed.*" Thus, claim 9 requires that the nozzle outlet be formed in the side of the plate toward which the beam is directed. Neither Shei nor Nishiwaki teach or suggest this limitation.

Clearly, Shei does not disclose impinging a beam on a nozzle plate, much less forming a nozzle outlet or a nozzle in such a plate. In order for the claim rejection to stand, Nishiwaki necessarily must provide this teaching. Nishiwaki, however, also does not explicitly or implicitly disclose this limitation.

To illustrate, Fig. 3 in Nishiwaki discloses ablation of a work piece 12 and shows an inward taper. In other words, the diameter of the hole formed in the face impinged by the beam is disclosed as *greater than* the diameter of the hole in the opposite side or beam exit side. For an ink jet nozzle, the nozzle outlet is typically smaller than the nozzle inlet. Thus, Nishiwaki does not depict a beam impinging on a face of the work piece or nozzle plate in which the nozzle outlet is formed, as recited in claim 9.

Thus, the combination of Shei and Nishiwaki fails to teach or suggest all of the limitations of claim 9 and, thus, the rejection should be withdrawn as to claim 9. For at least this reason, claim 9 is in condition for allowance.

### No Motivation to Combine Reference Teachings

There is no motivation or suggestion to combine the teachings of Nishiwaki and Shei as proposed in the action for at least two reasons.<sup>1</sup> First, neither of the references provides the necessary motivation or suggestion to combine the reference teachings. Second, Shei is neither directed to an analogous field of endeavor nor does it address problems reasonably pertinent to the problems facing the inventors of the instant application.<sup>2</sup>

First we address the lack of motivation or suggestion to combine the references as proposed in the action. Nishiwaki discloses a method of manufacturing nozzles in a nozzle plate for an ink jet printhead and Shei discloses a beam homogenizer for laser eye surgery. The prior art teachings must provide the necessary motivation or suggestion.

Nishiwaki does not do so. Fig. 7 and column 5, line 58 through column 6, line 8 in Nishiwaki describe only that *a beam shaping device* can be positioned upstream of the disclosed beam 3 between the beam source 2 and the beam splitter 6. The *beam shaping* device is disclosed as including a mask 20 having an elliptical opening and a further series of lenses 22, 24, 26, and 28. The mask and lenses are used to shape the beam into a circular cross section to match that of the disclosed flyeye lens 4. This beam shaper is disclosed only to conform the *shape* of the beam 3 to match that of the flyeye lens 4 so that little or no beam energy is wasted. Nishiwaki *does not disclose or suggest a beam homogenizer*, nor any means or desire to even out or otherwise change beam intensity over the beam cross section. Thus, Nishiwaki does not provide the necessary suggestion or motivation to modify the method disclosed therein by employing the homogenizer of Shei.

Shei discloses a controllable laser energy deliver system specifically suited for photorefractive keratectomy for correcting vision imperfections in patients. Shei discloses, almost in passing, an image rotator-beam homogenizer 130 without disclosing its specifics. Shei does disclose that, at column 5, lines 7-9, the "profile of the circular laser beam 140

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<sup>1</sup> A *prima facie* case of obviousness requires that three criteria be met. These criteria include: a) all claim limitations must be taught within the cited references; b) there must be a reasonable expectation to succeed in making the combination; and, c) the motivation or suggestion to combine the reference teachings must be found either within the references themselves, or within the knowledge generally known at the time of the invention to one having ordinary skill in the art.

<sup>2</sup> In determining whether a piece of prior art is analogous to an invention, the Federal Circuit applies a two-step test. The first step is to determine if the field of endeavor of the prior art is within the inventor's field of endeavor. If not, the second step is to determine whether the problem addressed in the prior art reference is reasonably pertinent to the problem facing the inventors at the time of the invention. *In re Deminski*, 796 F.2d 436, 442 (Fed. Cir. 1986).

generated by the image rotator and beam homogenizer 130 has an (*sic*) uniform intensity distribution." However, the sole purpose of the device as disclosed in Shei is for performing laser eye surgery, a highly precise and potentially dangerous procedure, which, if performed carelessly or with unsatisfactory equipment, could seriously injure a patient or damage there vision. Shei does not mention other uses for the disclosed homogenizer 130, nor does Shei address its purpose or importance. Shei makes no mention of ink jet printers, printheads or the like. Shei is primarily directed to controlling the beam application cycle during eye surgery. Thus, Shei also does not provide the necessary motivation or suggestion to modify the Nishiwaki method by employing the homogenizer of Shei.

The action states that "it would have been obvious for one of ordinary skill in the art to have provided an optical homogenizer system including a first, second and third reflecting means that rotate as taught by Shei *et al.* ('238) in the process of Nishiwaki *et al.* ('250) because, Shei *et al.* ('238) specifically teaches that such a homogenizer reshapes and homogenizes the beam in a circular fashion, hence improving the quality of the resulting nozzles." This stated motivation or suggestion put forth in the action is incorrect and not supported by the prior art. The last excerpt, "hence improving the quality of the resulting nozzles," upon which the rejection is based, is not found within either reference. Instead, it can only be found within the applicants' own disclosure, as demonstrated above. Neither Nishiwaki, Shei, nor any knowledge generally known to those having ordinary skill in the art at the time of the applicants' invention, provides such motivation.

There would have been no motivation or suggestion to modify Nishiwaki in accordance with the teachings of Shei, at the time of the applicants' invention. For at least this reason, the obviousness rejection of claims 9, 23, and 31 and dependent claim 24 should be withdrawn.

Secondly, Shei is non-analogous to the teachings of the present invention. Applying the two-part test, Shei is directed to laser eye surgery and the instant application is directed to forming ink jet print heads. These are two completely different fields of endeavor. The first step of the test is not met.

The second step is also not met. The inventors of the instant application were specifically concerned with solving problems associated with *forming a tapered nozzle configuration*, wherein the nozzle taper could be controlled and defined with particular precision. By utilizing a beam former as disclosed in Nishiwaki, the beam can have non-

uniform intensity over its cross section. This non-uniform intensity can result in a nozzle that is of a non-symmetric or undesirable taper. Nishiwaki does not address tapered nozzle formation nor uniform beam intensity. The inventors of the instant application have learned that by utilizing a beam homogenizer to create a uniform beam intensity during nozzle formation, the parameters and characteristics of a tapered nozzle formed by the inventors' method can be precisely controlled and accurately manufactured.

There are fundamental differences between the methods and apparatus' used in laser surgery (Shei) and the methods and apparatus' used for nozzle ablation (the instant invention). One fundamental difference is that in ink jet printer nozzles, the beam is focused on one point and applied at that point until an aperture is formed completely through the nozzle plate substrate. By rotating the beam, the inventors have found that the circularity of the nozzle is improved. This nozzle quality ensures, for example, a uniform ejection direction.

In laser surgery, thin layers of corneal material are removed to flatten the shape of the cornea by limiting the duration of focus of the beam at a given point and by redirecting the beam to different points. The depth of the "hole" or material removal at each laser beam focal point must be tightly controlled to prevent under-correction or over-correction. Therefore, it is not the circularity of the "hole" at each material removal point in Shei that is important. Instead, it is the depth of the material removed or the cut at each focal point of the beam that is important. Hot spots in the Shei beam, if not homogenized, may result in an incorrect correction depth (see col. 1, line 47).

Controlling the *depth* of a through-hole in an ink jet nozzle plate was not a problem facing the inventors at the time of the present invention. This is because a nozzle is an aperture extending completely through the nozzle plate. Thus, the depth is controlled by the plate thickness and not by the beam or any beam characteristic.

Shei is completely unrelated to solving problems associates with forming tapered holes in substrates, much less problems of symmetry in forming such holes. Shei does not mention any such problems, and is not remotely concerned with even similar problems that might occur during eye surgery. Thus, Shei is not concerned with solving problems that are reasonably pertinent to those facing the inventors at the time of the present invention. The second step has also not been met.

Because Shei is not reasonably pertinent to the problems facing the inventors of the instant application, and because Shei is not from a technical field analogous to the applicants'

disclosure, Shei is not available as prior art to this invention. For at least this additional reason, there would have been no motivation or suggestion to modify Nishiwaki in accordance with the teachings of Shei, at the time of the applicants' invention. The obviousness rejection of claims 9, 23, and 31 and dependent claim 24 should be withdrawn.

Claims 25 and 35 have been rejected as obvious over a combination of Nishiwaki and Shei, and further in view of either Hizny or Daly. Each of these rejections, however, is under pinned by the improper combination of Nishiwaki and Shei. Neither Daly nor Hizny provides the necessary and absent motivation or suggestion to combine the teachings of Nishiwaki and Shei. Claims 25 and 35 are, therefore, also not rendered obvious by the purported combinations.

### CONCLUSION

Claims 9, 23-25, 31, 34, and 35 are in condition for allowance in view of the foregoing amendments and remarks. Reconsideration and withdrawal of the various rejections are hereby respectfully solicited.

The examiner is invited to contact the undersigned at the telephone number listed below in order to discuss any remaining issues or matters of form that will place this case in condition for allowance.

No fee is believed due at this time. However, the Commissioner is hereby authorized to charge any fee deficiency, or to credit any overpayments, to Deposit Account No. 13-2855 of the undersigned's firm.

Respectfully submitted,



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## Version Showing Changes Made

### In the Claims

Please amend claims 23 and 31 as follows:

23. (Amended) Method of forming a nozzle in a nozzle plate for an ink jet printhead, the nozzle having a nozzle inlet and a nozzle outlet in respective opposite faces of said nozzle plate, characterised by the steps of:

directing a high energy beam having a first axis extending in a first direction towards said nozzle plate; directing said beam at a first reflecting surface lying at an angle to said first direction, said surface being arranged so as to reflect[,] said beam towards a second reflecting surface and a third reflecting surface so arranged as to both invert said beam and direct said beam along an axis [collinear] colinear with said first axis extending in a first direction; said first, [and] second, and third surfaces being fixedly located relative to one another, thereby to form an assembly, and rotating said assembly about said first axis; said beam thereafter impinging on said nozzle plate, thereby to form a nozzle.

31. (Amended) Apparatus for forming a nozzle in a nozzle plate for an ink jet printhead, said apparatus comprising a nozzle plate substrate and a source of a high energy beam having a first axis extending in a first direction; and an assembly comprising a first reflecting surface lying at an angle to said first reflecting surface lying at an angle to said first direction, [and] a second reflecting surface, and a third reflecting surface, said first, [and] second, and third reflecting surfaces being fixedly located relative to one another such that said high energy beam is reflected by said first reflecting surface towards said second reflecting surface and said third reflecting surface, thereby to both invert said beam and direct said beam along [on] a second axis [collinear] colinear with said first axis extending in [a] the first direction; said assembly being rotatable about said first axis, and said nozzle plate substrate being partly disposed within a path defined by said second axis to be impinged upon by said beam.